Volatiles in high-K lunar basalts

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Chlorine is an unusual isotopic system, being essentially unfractionated ($\delta^{37}Cl$ ~0‰) between bulk terrestrial samples and chondritic meteorites and yet showing large variations in lunar (~-4 to +81‰), martian, and vestan (HED) samples. Among lunar samples, the volatile-bearing mineral apatite ($Ca_5(PO_4)_3[F,Cl,OH]$) has been studied for volatiles in K-, REE-, and P (KREEP), very high potassium (VHK), low-Ti and high-Ti basalts, as well as samples from the lunar highlands. These studies revealed a positive correlation between *in-situ* $\delta^{37}Cl$ measurements and bulk incompatible trace elements (ITEs) and ratios (Boyce et al. 2015 *Sci. Adv*., Barnes et al., 2016 *EPSL*). Such trends were interpreted to originate from Cl isotopic fractionation during the degassing of metal chlorides during or shortly after the differentiation of the Moon via a magma ocean.

In this study, we investigate the volatile inventories of a group of samples for which new-era volatile data have yet to be reported – the high-K (>2000 ppm bulk K_2O), high-Ti, trace element-rich mare basalts. We used isotope imaging on the Cameca NanoSIMS 50L at JSC to obtain the Cl isotopic composition $[((^{37}Cl/^{35}Cl_{sample}/^{37}Cl/^{35}Cl_{standard})-1)\times1000$, to get a value in per thousand (‰)] which ranges from ~-2.7 ± 2‰ to +16.1 ± 2‰ (2σ), as well as volatile abundances (F & Cl) of apatite in samples 10017, 10024 & 10049.

Simply following prior models, as lunar rocks with high bulk-rock abundances of ITEs we might expect the high-K, high-Ti basalts to contain apatite characterized by heavily fractionated $\delta^{37}Cl$ values, i.e., Cl obtained from mixing between unfractionated mantle Cl (~ 0‰) and the urKREEP reservoir (possibly fractionated to >+25‰, Boyce et al. 2015 *Sci. Adv*.). However, the data obtained for the studied samples do not conform to either the early degassing or mixing models. Existing petrogentic models for the origin of the high-K, high-Ti basalts do not include urKREEP assimilation into their LMO cumulate sources. Therefore, Cl in these basalts either originated from source region heterogeneity or through assimilation or metasomatism by volatile and incompatible trace element rich materials. The new data presented here could provide evidence for the existence of region(s) in the lunar interior that are ITE-enriched and contain Cl that does not share isotopic affinities with lunar urKREEP, possibly representing the composition of the purported 'neuKREEP' (Jerde et al. 1994 *GCA*).